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Atty. Dkt. No. 039153-0325

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Babcock et al.

Title: PHASE-SHIFTING MASK WITH TRENCHES HAVING MULTIPLE DEPTHS

Appl. No.: 10/047,610

Filing Date: 01/16/2002

Examiner: Stephen D. Rosasco

Art Unit: 1756

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TRANSMITTAL OF APPEAL BRIEF

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Transmitted herewith are the following documents for the above-identified application.

[X] Brief on Appeal (in triplicate, 23 pages each).

[X] Check number 14160 for $330.00 in payment of Appeal Brief filing fee.

Please direct all correspondence to the undersigned attorney or agent at the address indicated below.

Respectfully submitted,

Date 6/15/04

By

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Atty. Dkt. No. 039153-0325

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Appellants: Babcock et al.

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BRIEF ON APPEAL

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Sir:

This paper is being filed in response to the final Office Action dated January 21, 2004 (finally rejecting Claims 1-14 and allowing Claims 15-22). The Notice of Appeal was filed on April 15, 2004. Appellants respectfully request reconsideration of the application.

Under the provisions of 37 C.F.R. § 1.192, this Appeal Brief is being filed in triplicate together with a check in the amount of $330.00 covering the 37 C.F.R. § 1.17(c) appeal fee. If this fee is deemed to be insufficient, authorization is hereby given to charge any deficiency (or credit any balance) to the undersigned deposit account 06-1447.

REAL PARTY IN INTEREST

This application has been assigned of record to Advanced Micro Devices, Inc. having a place of business at 1160 Kern Avenue, Sunnyvale, California 94088. The assignment was recorded in the records of the United States Patent and Trademark Office at Reel/Frame 012510/0018 on January 16, 2002.

RELATED APPEALS AND INTERFERENCES

There are no related appeals or interferences.

STATUS OF CLAIMS

This is an appeal from the final Office Action dated January 21, 2004, in which Claims 15-22 were allowed and Claims 1-14 were finally rejected. Claims 1-14 are therefore on appeal.

STATUS OF AMENDMENTS

No claims have been amended subsequent to the mailing date of the final Office Action dated January 21, 2004.

SUMMARY OF INVENTION

The present invention relates generally to the field of fabrication processes for integrated circuits. (See Specification, page 1, paragraph [0002]). By way of background, phase-shifting mask technology has been used to improve the resolution and depth of focus in photolithographic processes. (See Specification, page 2, paragraph [0005]). Photolithographic masks are used to selectively alter the phase of the light passing through certain areas of the mask to take advantage of destructive interference to improve resolution and depth of focus. (See Specification, page 2, paragraph [0005]). Often times the optimal wavelength of light must be determined by performing a lithography test with photolithographic equipment having different wavelengths, and two different phase-shifting masks must be fabricated, each mask having trenches suitable for phase-shifting light of the desired wavelength. (See Specification, page 3, paragraph [0007]).

According to an exemplary embodiment, a mask (26) includes a transparent layer (34) comprising any transparent material, such as, quartz, glass, fused silica, etc. (See Specification, pages 6-7, paragraph [0021] and Figure 3). Transparent layer (34) includes a first region of trenches (36) having a first depth. (See Specification, page 7, paragraph

[0021]). Mask (26) further includes a second region of trenches (38) having a second depth deeper than the first depth. (Id.). The first depth is shallower than the second depth; the first depth is suitable for phase-shifting light received at a light-receiving side (40) of mask (26) and transmitted through a light-sending side (42) of mask (26), while the second depth is suitable for phase-shifting light having a second wavelength longer than the first wavelength which is received at light-receiving side (40) and transmitted through light-sending side (42). (Id.).

To produce mask (26), trenches (58) are etched in layer (34) using a conventional mask and etch process. (See Specification, page 9, paragraph [0025] and Figure 4). Trenches (58) all have a first depth, such as depth (46), which is suitable to phase-shift light having a first wavelength by 180 degrees. (Id.). A resist layer (60) is then applied over a portion (e.g., at least one quarter) of surface (44) of transparent layer (34), thereby defining first region (36) and second region (38). (See Specification, page 9, paragraph [0026]). Mask (26) is then re-etched, whereby only second region (38) is etched, such that trenches (52) in region (38) are etched to a deeper depth than trenches (58). (See Specification, page 10, paragraph [0027]). Trenches (50) are therefore formed having a first depth suitable for phase-shifting light of a first wavelength, while trenches (52) have a second, deeper depth suitable for phase-shifting light having a second wavelength longer than the first wavelength. (See Specification, page 10, paragraph [0028] and Figure 6).

Advantageously, one may utilize the mask (26) for testing or research and development to compare the capabilities of the longer wavelength printing process versus the shorter wavelength printing process, and two masks need not be fabricated, which saves cost, materials, and time. (See Specification, page 11, paragraph [0030]). Further still, a direct side-by-side comparison of the two different wavelength printing processes may be observed. (Id.). Further yet, since a mask with dual wavelength capability has a section for each wavelength manufactured on the same substrate, the manufacturing offset or bias will be the same. (Id.).

ISSUES

One issue is presented in this appeal, and is concisely described as follows: Whether Claims 1-14 are unpatentable under 35 U.S.C. § 103(a) over U.S. Patent No. 6,068,951 to Pierrat et al. or U.S. Patent No. 5,700,605 to Ito et al. in view of U.S. Patent No. 5,549,995 to Tanaka et al.

GROUPING OF CLAIMS

The grouping of the claims is as follows:

Claims 1-4 and 8 are grouped together as being directed to a phase-shifting mask for a photolithographic process.

Claim 5 stands alone as being directed to a phase-shifting mask for a photolithographic process.

Claim 6 stands alone as being directed to a phase-shifting mask for a photolithographic process.

Claim 7 stands alone as being directed to a phase-shifting mask for a photolithographic process.

Claims 9 and 13-14 are grouped together as being directed to a phase-shifting mask for a photolithographic process.

Claim 10 stands alone as being directed to a phase-shifting mask for a photolithographic process.

Claim 11 stands alone as being directed to a phase-shifting mask for a photolithographic process.

Claim 12 stands alone as being directed to a phase-shifting mask for a photolithographic process.

To the extent that the claims in these groups are argued separately below, the claims do not stand or fall together.

ARGUMENT

I. LEGAL STANDARDS

Claims 1-14 have been rejected under 35 U.S.C. § 103(a), which states:

> A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The legal standards under 35 U.S.C. § 103(a) are well-settled. Obviousness under 35 U.S.C. § 103(a) involves four factual inquiries: 1) the scope and content of the prior art; 2) the differences between the claims and the prior art; 3) the level of ordinary skill in the pertinent art; and 4) secondary considerations, if any, of nonobviousness. See Graham v. John Deere Co., 383 U.S. 1, 148 U.S.P.Q. 459 (1966).

In proceedings before the Patent and Trademark Office, the Examiner bears the burden of establishing a prima facie case of obviousness based upon the prior art. In re Piasecki, 745 F.2d 1468, 1471-72, 223 U.S.P.Q. 785, 787-88 (Fed. Cir. 1984). "'[The Examiner] can satisfy this burden only by showing some objective teaching in the prior art or that knowledge generally available to one of ordinary skill in the art would lead that individual to combine the relevant teachings of the references.'" In re Fritch, 972 F.2d 1260, 1265, 23 U.S.P.Q.2d 1780, 1783 (Fed. Cir. 1992).

As noted by the Federal Circuit, the "factual inquiry whether to combine references must be thorough and searching." McGinley v. Franklin Sports, Inc., 262 F.3d 1339, 60 USPQ.2d 1001 (Fed. Cir. 2001). Further, it "must be based on objective evidence of record." In re Lee, 277 F.3d 1338, 61 USPQ.2d 1430 (Fed. Cir. 2002). The teaching or suggestion to make the claimed combination must be found in the prior art, and not in the applicant's

disclosure. In re Vaeck, 947 F.2d 488, 20 USPQ.2d 1438 (Fed. Cir. 1991). The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination. In re Mills, 916 F.2d 680, 16 USPQ.2d 1430 (Fed. Cir. 1990). "It is improper, in determining whether a person of ordinary skill would have been led to this combination of references, simply to '[use] that which the inventor taught against its teacher.'" Lee (citing W.L. Gore v. Garlock, Inc., 721 F.2d 1540, 1553, 220 USPQ 303, 312-13 (Fed. Cir. 1983)).

II. REJECTION OF CLAIMS 1-14 UNDER 35 U.S.C. § 103(a) OVER PIERRAT ET AL. OR ITO ET AL. IN VIEW OF TANAKA ET AL.

In the Office Action dated January 21, 2004, Claims 1-14 were rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,068,951 to Pierrat et al. or U.S. Patent No. 5,700,605 to Ito et al. in view of U.S. Patent No. 5,549,995 to Tanaka et al.

For the reasons given below, the Appellants submit that the rejection of Claims 1-14 is improper and should be reversed.

A. The Examiner's Rejection of Claims 1-14 Should be Reversed Because There is No Suggestion to Combine the Teachings of Pierrat et al. or Ito et al. with those of Tanaka et al.

To establish a prima facie case of obviousness based on a combination of prior art references under 35 U.S.C. § 103(a), the Examiner must first show that there is a suggestion or motivation to combine the teachings of those references. This may come in the form of some objective teaching in the prior art or, alternatively, knowledge generally available to one of ordinary skill in the art at the time of the invention that would lead that individual to combine the relevant teachings of the references.

When the motivation to combine the teachings of the references is not immediately apparent, it is the duty of the Examiner to explain why the combination of the teachings is proper. Ex parte Skinner, 2 USPQ.2d 1788 (Bd. Pat. App. & Inter. 1986).

The Appellants submit that the Examiner has not satisfied the burden of showing that there is a suggestion or motivation, either in the references themselves or in the knowledge

generally available to one of ordinary skill in the art, to modify the references or to combine the teachings of the cited references in the manner suggested (see, e.g., M.P.E.P. § 2143). For example, the Examiner stated in the final Office Action dated January 21, 2004 (with emphasis added):

> It would have been obvious to one having ordinary skill in the art to take the teachings of Pierrat et al. or Ito et al. and combine them with the teachings of Tanaka et al. in order to make the claimed invention because it is well known in the phase shifting mask art that the depth of trench can be adjusted to transmit light that is shifted by a desired amount.

The Appellants submit that statement by the Examiner is inadequate to provide a proper motivation to one of ordinary skill in the art to modify the teachings of Pierrat et al. or Ito et al. in the manner suggested by the Examiner (i.e., to combine them with the teachings of Tanaka et al.). Instead, this statement merely indicates that it is "well known" that the "depth of trench can be adjusted to transmit light...." There is no suggestion in this statement that one of ordinary skill in the art would have been motivated, based on this "well known" information, to combine the teachings of the cited references.

For example, the Examiner has not provided any indication that any of the cited references include any statement whatsoever that it would be desirable or even possible to combine their teachings with those of the other references. Nor has the Examiner provided any specific reason as to why one of ordinary skill in the art would have been motivated to combine the teachings of these disclosures based on the "well known" information. As noted by the Federal Circuit, the mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination. In re Mills, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990) (emphasis added); see also M.P.E.P. § 2143.01.

The Office Action also illustrates that the Examiner has engaged in improper hindsight reasoning by selecting features from otherwise unrelated references in an attempt to render the claimed invention obvious. For example, the Examiner stated (with emphasis added):

> The examiner maintains the rejection on the grounds that the prior art amply demonstrates all of the features of the claimed invention and there [sic] function in the mask art, that the prior art has shown the use of two different wavelengths of light together in one mask and that the use of a second trench for phase shifting a second wavelength of light is a repetition of the first trench for the same purpose.

Thus, rather than showing a motivation to combine the cited references in the manner suggested, the Examiner instead has indicated that features of the claimed invention are "demonstrated" in the "mask art." However, the claims must be reviewed as a whole. It is the combination of elements recited in the claims that must be taught or suggested by the art. It is not sufficient to simply point out that various features are shown in various unrelated references. The only suggestion to make the combination recited in the rejected claims comes from the Appellants' own disclosure, and improper hindsight reasoning may not be used to render such a combination obvious.

Further, the combination of Pierrat et al. and Tanaka et al. proposed by the Examiner would change the principle of operation of Pierrat et al., which is improper. See, e.g., M.P.E.P. § 2143 and In re Ratti, 270 F.2d 810, 123 USPQ 349 (CCPA 1959). For example, Pierrat et al. relates to a phase shifting mask that includes apertures formed in a substrate to a single depth, with the depth of the aperture calculated such that it will "produce a 180° phase shift for λ_2 and an approximately 180° phase shift for λ_1." For example, Pierrat et al. states at column 2, lines 49-61:

> Mask 10 is designed such that light having a wave length of either λ_1 or λ_2 can be used. As the light passes through apertures 16 it has a phase of ϕ_1 As the light passes through apertures 18, both wave lengths λ_1 and λ_2 have a phase of ϕ_2. . . . Mask 10 will behave like an alternating aperture phase shifting mask for both λ_1 and λ_2 wave lengths.

In contrast, Tanaka et al. relates to a photomask that includes a substrate and a "portion of the substrate 11 corresponding to one opening pattern is etched to a depth D_1 and that of the substrate corresponding to another opening pattern is etched to a depth D_2" (column 6, lines 17-20). A "phase difference of 180 degrees is caused between adjacent opening patterns" (column 6, lines 35-36).

As shown in the disclosure of Tanaka et al., the depths D_1 and D_2 are determined based on a number of equations such that a particular wavelength of light is shifted 180 degrees. Pierrat et al. utilizes entirely different equations to arrive at a "common depth" that will allow phase shifting for two particular wavelengths of light. The principle of operation of Pierrat et al. is thus accordingly different from that used in Tanaka et al., and therefore the combination of these references would alter the principle of operation of Pierrat et al., which would be improper.

The rejection of Claims 1-14 should be reversed, because the Examiner has not shown that one of ordinary skill in the art would have been motivated at the time of the invention to combine the teachings of Pierrat et al. with those of Tanaka et al. or to combine the teachings of Ito et al. with those of Tanaka et al.

B. The Examiner's Rejection of Claims 1-14 Should be Reversed Because the Combination of Pierrat et al. or Ito et al. with Tanaka et al. Does Not Teach or Suggest At Least One Element of Each of the Rejected Claims

To establish prima facie obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. In re Royka, 490 F.2d 981, 180 U.S.P.Q. 580 (C.C.P.A. 1974). Even if Pierrat et al. or Ito et al. could be properly combined with Tanaka et al., the combination of these references do not teach or suggest at least one element of each of Claims 1-14. Accordingly, the rejection of these claims under 35 U.S.C. § 103(a) is improper and should be reversed.

For clarity, the combination of Pierrat et al. and Tanaka et al. is discussed below separately from the combination of Ito et al. and Tanaka et al.

1. The Combination of Pierrat et al. and Tanaka et al. Does Not Teach or Suggest At Least One Element of Each of the Rejected Claims

Independent Claim 1 recites a "phase-shifting mask," comprising, in combination with other elements, a "first trench having a first depth for phase-shifting light having a first wavelength" and a "second trench having a second depth deeper than the first depth for phase-shifting light having a second wavelength longer than the first wavelength."

Independent Claim 9 recites a "phase-shifting mask," comprising, in combination with other elements, a "first plurality of trenches having a first depth for phase-shifting light having a first wavelength" and a "plurality of second trenches" that "have a second depth deeper than the first depth for phase-shifting light having a second wavelength longer than the first wavelength."

Thus, each of Claims 1 and 9 require a single phase-shifting mask that include at least the following features: (1) a trench (or trenches) having a first depth for phase-shifting light having a first wavelength and (2) a second trench (or trenches) having a second depth for phase-shifting light having a second wavelength.

Such a phase-shifting mask represents an advance in the art that is not taught or suggested by any of the cited references, whether taken alone or in proper combination. For example, as described at paragraph [0007] (with emphasis added):

> As mentioned, various different wavelengths of light are used in different photolithographic processes. The optimal wavelength of light is based on many factors, such as the composition of the resist, the desired critical dimension (CD) of the integrated circuit, etc. Often times the optimal wavelength of light must be determined by performing a lithography test with photolithographic equipment having different wavelengths. When a phase-shifting mask technique is utilized, two different phase-shifting masks must be fabricated, each mask having trenches 16 suitable for phase-shifting light of the desired wavelength. The fabrication of phase-shifting masks is costly. Further, comparison of the effect of the two printing processes at the different wavelengths is difficult. Differences in manufacturing biases or offsets between different phase-shifting masks further complicates comparison of the effects of the two printing processes.

To illustrate the differences between the inventions claimed in Claims 1 and 9 and the teachings of the cited references, it may be useful to review the principles behind phase shifting masks. As described on page 2 of the Specification in paragraph [0005]:

> For example, in a simple case, each aperture in the phase-shifting mask transmits light 180 degrees out of phase from light passing through adjacent apertures. This causes any light

> overlapping from two adjacent apertures to interfere destructively, thereby reducing any exposure in the center "dark" area beneath an opaque layer, such as chrome.

By way of illustration, the exemplary embodiment shown in Figure 3 of the present application shows first trenches 50 and second trenches 52. Light of a first wavelength may be provided through first trenches 50 and through the adjacent surface regions of layer 34 of the mask 26 (the adjacent surface regions not covered by light blocking portions 56). The mask thus acts to phase shift the light traveling through trenches 50 relative to the light passing through the surface of layer 34. Similarly, light of a second wavelength may be provided through second trenches 52 and also through adjacent regions of layer 34 of the mask 26 (the adjacent surface regions not covered by light blocking portions 56). The mask thus acts to phase shift the light traveling through trenches 52 relative to the light passing through the surface of layer 34.

Pierrat et al. and Tanaka et al., whether taken alone or in proper combination, do not teach or suggest a single mask having trenches of different depths, each of the trenches having a depth that is configured for phase-shifting light of a different wavelength, as required by independent Claims 1 and 9.

As described above, Pierrat et al. describes the use of apertures of a single depth to obtain 180° phase shifts for two different wavelengths of light. Pierrat et al. describes such an arrangement at Column 2, lines 62-66 (with emphasis added):

> In order to design a phase shifting mask whereby a 180° phase shift is obtained at a first wave length and a 180° phase shift is obtained at a second wave length, it is necessary to find a common depth for the phase shifting layer 22 which will produce the desired phase shifts.

The Examiner describes the citation of Pierrat et al. in the present Office Action as follows (with emphasis added):

> This reference was cited by the examiner, because it shows what is required to perform exposure with two different wavelengths using the same depth for a phase shifting trench. The prior art obviously shows the relationship between

> exposure wavelength and depth of trench. And that a second trench with a different depth can be used to make a relative phase shift between the first and second trench, analogous to the shift from the surface and a first trench depth; and that a mask with a trench designed for phase shifting can be used with two different wavelengths, if the wavelengths were selected appropriately.

The Appellants note with regard to the first underlined portion in the preceding paragraph that the Examiner has not shown that Pierrat et al. teaches or suggests the use of a single mask that includes trenches having two different depths, with each of the depths being configured to phase shift light of different wavelengths. Instead, the Examiner properly notes that Pierrat et al. teaches only the use of "two different wavelengths using the same depth for a phase shifting trench."

The Appellants also note that the second underlined portion of the above paragraph appears to describe something similar to that disclosed by Tanaka et al. Tanaka et al. relates to a mask intended for use with a single wavelength of light and discloses a "transparent transmitting substrate 11" in which "a portion of the substrate 11 corresponding to one opening pattern is etched to a depth D_1 and that of the substrate corresponding to another opening pattern is etched to a depth D_2" (Column 6, lines 16-20 and Figures 3A-3E). Thus, a "relative phase shift" may be obtained between light of a single wavelength passing through the adjacent opening patterns D_1 and D_2.

While Tanaka et al. does disclose "opening patterns" etched to different depths (see Figure 3E), it does not teach or suggest the use of a single mask that includes trenches having different depths, each of the depths being configured for phase shifting light of a different wavelength.

As described in the present application at page 11 (paragraph [0030]), one advantageous feature of providing a single mask that includes trenches having different depths, each of the depths being configured for phase shifting light of a different wavelength is described:

> Advantageously, one may utilize the mask and system shown herein for testing or research and development to compare the capabilities of the longer wavelength printing process versus the shorter wavelength printing process. Further, two masks need not be fabricated, which saves cost, materials, and time. Further still, a direct side-by-side comparison of the two different wavelength printing processes may be observed. Further yet, since a mask with dual wavelength capability has a section for each wavelength manufactured on the same substrate, the manufacturing offset or bias will be the same.

The phase-shifting masks claimed in independent Claims 1 and 9 (and their corresponding dependent claims) enable one to obtain an advantage that is not taught or suggested by either Pierrat et al. or Tanaka et al. Neither Pierrat et al. nor Tanaka et al. appear to even recognize the difficulty associated with comparing different mask systems that is described in the present application, nor do they teach or suggest a phase-shifting mask in which it would be possible to obtain the advantage of being able to compare such systems.

The "phase-shifting mask" recited in independent Claims 1 and 9 would not have been obvious in view of Pierrat et al., alone or in any proper combination with Tanaka et al. under 35 U.S.C. § 103(a). Pierrat et al. alone or in any proper combination with Tanaka et al. does not disclose, teach or suggest a "phase-shifting mask" comprising, in combination with other elements, a "first trench (or plurality of trenches) having a first depth for phase-shifting light having a first wavelength" and a "second trench (or plurality of trenches) having a second depth deeper than the first depth for phase-shifting light having a second wavelength longer than the first wavelength."

To transform the subject matter taught by Pierrat et al. and the subject matter taught by Tanaka et al. into a "phase-shifting mask" as recited in Claims 1 and 9 would require further modification, and such modification is taught only by the Appellants' own disclosure. Accordingly, reversal of the rejection of Claims 1 and 9 (and associated dependent Claims 2-8 which depend from Claim 1 and dependent Claims 10-14 which depend from Claim 9) over the combination of Pierrat et al. and Tanaka et al. is respectfully requested.

2. The Combination of Ito et al. and Tanaka et al. Does Not Teach or Suggest At Least One Element of Each of the Rejected Claims

The combination of Ito et al. and Tanaka et al. also does not teach or suggest the subject matter recited in independent Claims 1 and 9. Ito et al. relates to a "light transparent substrate" that includes a "phase shift pattern" (Column 4, lines 33-39).

Ito et al. does not teach or suggest the use of a single mask that includes trenches having different depths for phase shifting light having two different wavelengths. In contrast, Ito et al. states at Column 4, lines 44-50 (with emphasis added):

> The substrate is characterized in that it is engraved at two kinds of depth, and the difference between respective engraved amounts approximately equals an engraved amount of the shallowly engraved part. Further, the substrate is characterized in that it has the phase difference of approximate 180 degree relative to the exposure light due to the difference between respective engraved amounts.

Thus, similar to Tanaka et al., the disclosure of Ito et al. seems to indicate that the mask described therein is intended for use with a single wavelength of light, and that phase-shifting occurs due to the difference between the depths of the engravings. There is no teaching or suggestion in Ito et al. that the substrate is "engraved at two kinds of depth" to allow one of the depths to shift a first wavelength of light and a second of the depths to shift a second, different wavelength of light. Nor is there any indication as to how such a configuration could be implemented.

As described in the present application at page 11 (paragraph [0030]), one advantageous feature of providing a single mask that includes trenches having different depths, each of the depths being configured for phase shifting light of a different wavelength is described:

> Advantageously, one may utilize the mask and system shown herein for testing or research and development to compare the capabilities of the longer wavelength printing process versus the shorter wavelength printing process. Further, two masks need not be fabricated, which saves cost, materials, and time. Further still, a direct side-by-side comparison of the two

> different wavelength printing processes may be observed. Further yet, since a mask with dual wavelength capability has a section for each wavelength manufactured on the same substrate, the manufacturing offset or bias will be the same.

The phase-shifting masks claimed in independent Claims 1 and 9 (and their corresponding dependent claims) enable one to obtain an advantage that is not taught or suggested by either Ito et al. or Tanaka et al. Neither Ito et al. nor Tanaka et al. appear to even recognize the difficulty associated with comparing different mask systems that is described in the present application, nor do they teach or suggest a phase-shifting mask in which it would be possible to obtain the advantage of being able to compare such systems.

The "phase-shifting mask" recited in independent Claims 1 and 9 would not have been obvious in view of Ito et al., alone or in any proper combination with Tanaka et al. under 35 U.S.C. § 103(a). Ito et al. alone or in any proper combination with Tanaka et al. does not disclose, teach or suggest a "phase-shifting mask" comprising, in combination with other elements, a "first trench (or plurality of trenches) having a first depth for phase-shifting light having a first wavelength" and a "second trench (or plurality of trenches) having a second depth deeper than the first depth for phase-shifting light having a second wavelength longer than the first wavelength."

To transform the subject matter taught by Ito et al. and the subject matter taught by Tanaka et al. into a "phase-shifting mask" as recited in Claims 1 and 9 would require further modification, and such modification is taught only by the Appellants' own disclosure. Accordingly, reversal of the rejection of Claims 1 and 9 (and associated dependent Claims 2-8 which depend from Claim 1 and dependent Claims 10-14 which depend from Claim 9) over the combination of Ito et al. and Tanaka et al. is respectfully requested.

B. The Examiner's Rejection of Various Dependent Claims Should be Reversed Because the Combination of Pierrat et al. or Ito et al. with Tanaka et al. Does Not Teach or Suggest At Least One Element of Each of the Rejected Claims

The Appellants also note that various dependent claims appear to be allowable over the cited references for reasons in addition to those described above. The Appellant notes that the Examiner has not, in any of the preceding Office Actions, addressed the features of

the dependent claims of the present application, and accordingly has not specified the rationale underlying the rejections of these claims in view of Ito et al. or Pierrat et al. in view of Tanaka et al.

1. The Combination of Ito et al. and Tanaka et al. or Pierrat et al. and Tanaka et al. Also Does Not Teach or Suggest At Least One Element of Dependent Claim 5

Ito et al. or Pierrat et al. in view of Tanaka et al. do not teach or suggest every limitation of dependent Claim 5.

Claim 5, which depends from independent Claim 1, recites "the transparent material includes a first region of trenches including the first trench, the first region of trenches including a plurality of trenches having the first depth, wherein the transparent material includes a second region of trenches including the second trench, the second region of trenches including a plurality of trenches having the second depth."

None of the cited references teach or suggest such a configuration for a phase-shifting mask. As described above, none of the cited references describes a phase-shifting mask that includes (1) trenches having a first depth for phase-shifting light having a first wavelength and (2) trenches having a second depth for phase-shifting light having a second wavelength. Further, there is no description in any of the cited references, whether taken alone or in any proper combination, to provide a plurality of the trenches having a first depth in a first region and a plurality of the trenches having a second depth in a second region.

Accordingly, reversal of the rejection of Claim 5 over the combination of Pierrat et al. or Ito et al. and Tanaka et al. is respectfully requested.

2. The Combination of Ito et al. and Tanaka et al. or Pierrat et al. and Tanaka et al. Also Does Not Teach or Suggest At Least One Element of Dependent Claim 6

Ito et al. or Pierrat et al. in view of Tanaka et al. do not teach or suggest every limitation of dependent Claim 6.

Claim 6 depends from Claim 5 and recites "the first region comprises at least one-fourth of the surface area of one side of the transparent material and the second region comprises at least one-fourth of the surface area of the one side of the transparent material."

As described above with respect to Claim 5, none of the cited references, whether alone or in proper combination, teach or suggest a phase-shifting mask that includes trenches having a first depth for phase-shifting light having a first wavelength and trenches having a second depth for phase-shifting light having a second wavelength, nor do any of the cited references teach or suggest an arrangement in which a plurality of the trenches having a first depth are provided in a first region while a plurality of the trenches having a second depth are provided in a second region. Further, none of the cited references, whether alone or in proper combination, teach or suggest that each of the first and second regions comprise at least one-fourth of the surface area of the one side of the transparent material used to form the phase-shifting mask.

Accordingly, reversal of the rejection of Claim 6 over the combination of Pierrat et al. or Ito et al. and Tanaka et al. is respectfully requested.

3. The Combination of Ito et al. and Tanaka et al. or Pierrat et al. and Tanaka et al. Also Does Not Teach or Suggest At Least One Element of Dependent Claim 6

Ito et al. or Pierrat et al. in view of Tanaka et al. do not teach or suggest every limitation of dependent Claim 7.

Claim 7 depends from Claim 5 and recites "the first region comprises approximately one-half of the surface area of one side of the transparent material and the second region comprises approximately one-half of the surface area of the one side of the transparent material."

As described above with respect to Claim 5, none of the cited references, whether alone or in proper combination, teach or suggest a phase-shifting mask that includes trenches having a first depth for phase-shifting light having a first wavelength and trenches having a second depth for phase-shifting light having a second wavelength, nor do any of the cited

references teach or suggest an arrangement in which a plurality of the trenches having a first depth are provided in a first region while a plurality of the trenches having a second depth are provided in a second region. Further, none of the cited references, whether alone or in proper combination, teach or suggest that each of the first and second regions comprise at least one-half of the surface area of the one side of the transparent material used to form the phase-shifting mask.

Accordingly, reversal of the rejection of Claim 7 over the combination of Pierrat et al. or Ito et al. and Tanaka et al. is respectfully requested.

4. The Combination of Ito et al. and Tanaka et al. or Pierrat et al. and Tanaka et al. Also Does Not Teach or Suggest At Least One Element of Dependent Claim 10

Ito et al. or Pierrat et al. in view of Tanaka et al. do not teach or suggest every limitation of dependent Claim 10.

Claim 10 depends from Claim 9 and recites "the resist layer covers a first subset of the first trenches and leaves a second subset of the first trenches exposed, wherein the second subset of first trenches are etched to form the second plurality of trenches."

As described above, none of the cited references describes a phase-shifting mask that includes (1) trenches having a first depth for phase-shifting light having a first wavelength and (2) trenches having a second depth for phase-shifting light having a second wavelength. Further, there is no description in any of the cited references, whether taken alone or in any proper combination, to first etch a plurality of trenches to a first depth, then to cover a subset of the trenches with a resist layer such that the uncovered trenches may be etched to a second depth to form a plurality of second trenches having a second depth greater than the first depth.

Accordingly, reversal of the rejection of Claim 10 over the combination of Pierrat et al. or Ito et al. and Tanaka et al. is respectfully requested.

5. The Combination of Ito et al. and Tanaka et al. or Pierrat et al. and Tanaka et al. Also Does Not Teach or Suggest At Least One Element of Dependent Claim 11

Ito et al. or Pierrat et al. in view of Tanaka et al. do not teach or suggest every limitation of dependent Claim 11.

Claim 11 depends from Claim 9 and recites "the resist layer covers at least one-fourth of one side of the transparent material."

As described above, none of the cited references describes a phase-shifting mask that includes (1) trenches having a first depth for phase-shifting light having a first wavelength and (2) trenches having a second depth for phase-shifting light having a second wavelength. Further, there is no description in any of the cited references, whether taken alone or in any proper combination, that a resist layer is provided over a portion of the transparent material of the phase-shifting mask such that the resist layer covers at least one-fourth of one side of the transparent material.

Accordingly, reversal of the rejection of Claim 11 over the combination of Pierrat et al. or Ito et al. and Tanaka et al. is respectfully requested.

6. The Combination of Ito et al. and Tanaka et al. or Pierrat et al. and Tanaka et al. Also Does Not Teach or Suggest At Least One Element of Dependent Claim 12

Ito et al. or Pierrat et al. in view of Tanaka et al. do not teach or suggest every limitation of dependent Claim 12.

Claim 12 depends from Claim 9 and recites "the resist layer covers approximately one-half of one side of the transparent material."

As described above, none of the cited references describes a phase-shifting mask that includes (1) trenches having a first depth for phase-shifting light having a first wavelength and (2) trenches having a second depth for phase-shifting light having a second wavelength. Further, there is no description in any of the cited references, whether taken alone or in any proper combination, that a resist layer is provided over a portion of the transparent material of

the phase-shifting mask such that the resist layer covers approximately one-half of one side of the transparent material.

Accordingly, reversal of the rejection of Claim 12 over the combination of Pierrat et al. or Ito et al. and Tanaka et al. is respectfully requested.

CONCLUSION

In view of the foregoing, the Appellants submit that Claims 1-14 are not properly rejected under 35 U.S.C. § 103(a) over the combination of Pierrat et al. or Ito et al. and Tanaka et al. and are patentable.

Accordingly, Appellants respectfully requests that the Board reverse all claim rejections and indicate that a Notice of Allowance respecting all pending claims should be issued.

Respectfully submitted,

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APPENDIX – THE CLAIMS ON APPEAL

1. A phase-shifting mask for a photolithographic process, comprising a transparent material having first and second trenches, the first trench having a first depth for phase-shifting light having a first wavelength and the second trench having a second depth deeper than the first depth for phase-shifting light having a second wavelength longer than the first wavelength.

2. The phase-shifting mask of claim 1, wherein the first depth is suitable for phase-shifting light having a wavelength of 193 nm by 180 degrees.

3. The phase-shifting mask of claim 1, wherein the first depth is suitable for phase-shifting the first light by 180 degrees and the second depth is suitable for phase-shifting the second light by 180 degrees.

4. The phase-shifting mask of claim 1, wherein the first depth is suitable for phase-shifting light having a wavelength of 248 nm by 180 degrees.

5. The phase-shifting mask of claim 1, wherein the transparent material includes a first region of trenches including the first trench, the first region of trenches including a plurality of trenches having the first depth, wherein the transparent material includes a second region of trenches including the second trench, the second region of trenches including a plurality of trenches having the second depth.

6. The phase-shifting mask of claim 5, wherein the first region comprises at least one-fourth of the surface area of one side of the transparent material and the second region comprises at least one-fourth of the surface area of the one side of the transparent material.

7. The phase-shifting mask of claim 5, wherein the first region comprises approximately one-half of the surface area of one side of the transparent material and the second region comprises approximately one-half of the surface area of the one side of the transparent material.

8. The phase-shifting mask of claim 1, further comprising an opaque layer fabricated on the transparent material, the opaque layer representing a printed circuit pattern.

9. A phase-shifting mask for a photolithographic process manufactured by the steps of:

providing a transparent material;

patterning a plurality of first trenches in the transparent material, the first plurality of trenches having a first depth for phase-shifting light having a first wavelength;

providing a resist layer over a portion of the transparent material; and

etching a plurality of second trenches in the transparent material until the second trenches have a second depth deeper than the first depth for phase-shifting light having a second wavelength longer than the first wavelength.

10. The phase-shifting mask of claim 9, wherein the resist layer covers a first subset of the first trenches and leaves a second subset of the first trenches exposed, wherein the second subset of first trenches are etched to form the second plurality of trenches.

11. The phase-shifting mask of claim 9, wherein the resist layer covers at least one-fourth of one side of the transparent material.

12. The phase-shifting mask of claim 9, wherein the resist layer covers approximately one-half of one side of the transparent material.

13. The phase-shifting mask of claim 9, further comprising patterning an opaque layer over the transparent material.

14. The phase-shifting mask of claim 9, wherein the first depth is suitable to phase-shift the first wavelength of light passing through the first plurality of trenches by 180 degrees and the second depth is suitable to phase-shift the second wavelength of light passing through the second plurality of trenches by 180 degrees.